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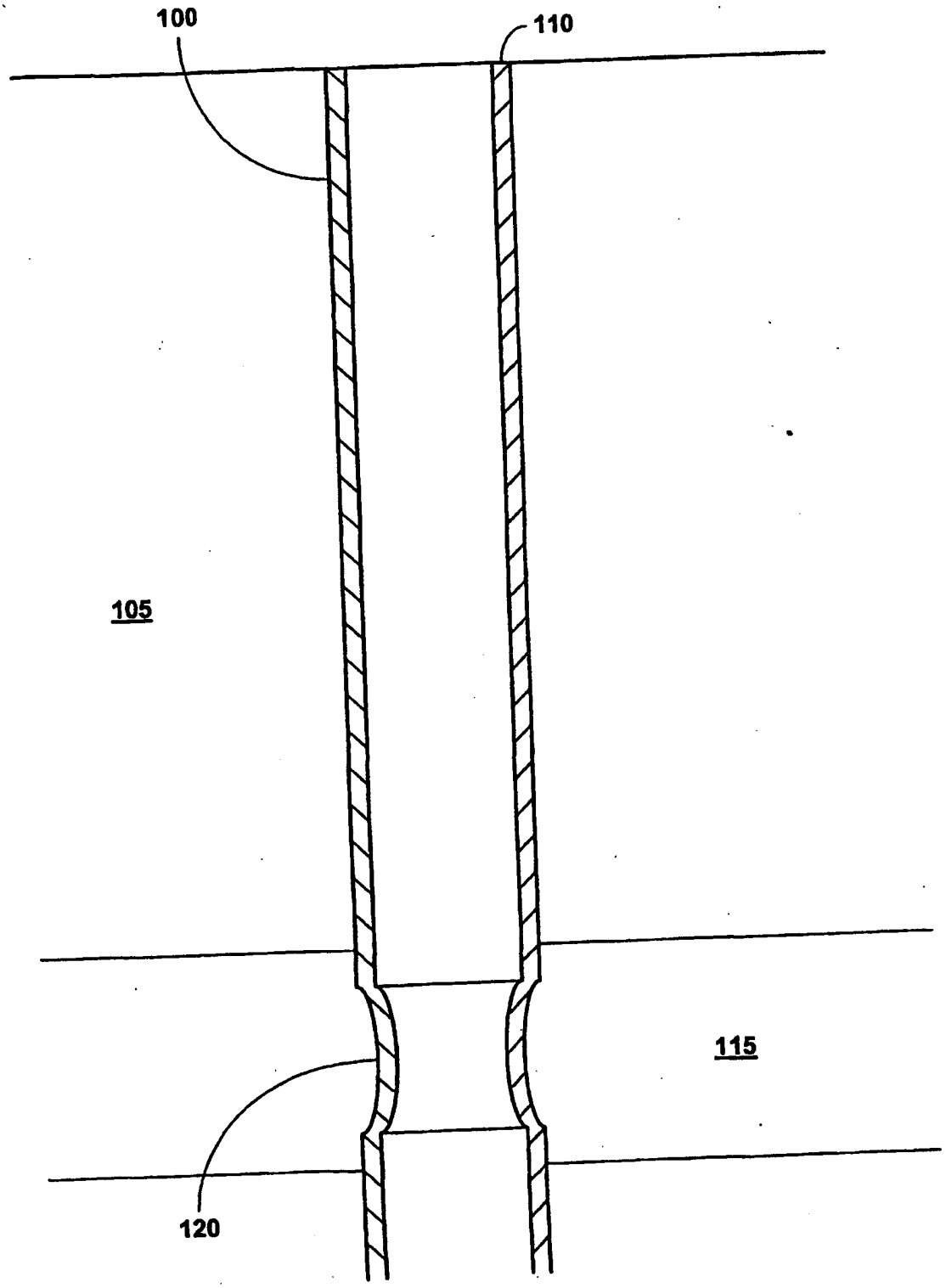


FIGURE 1

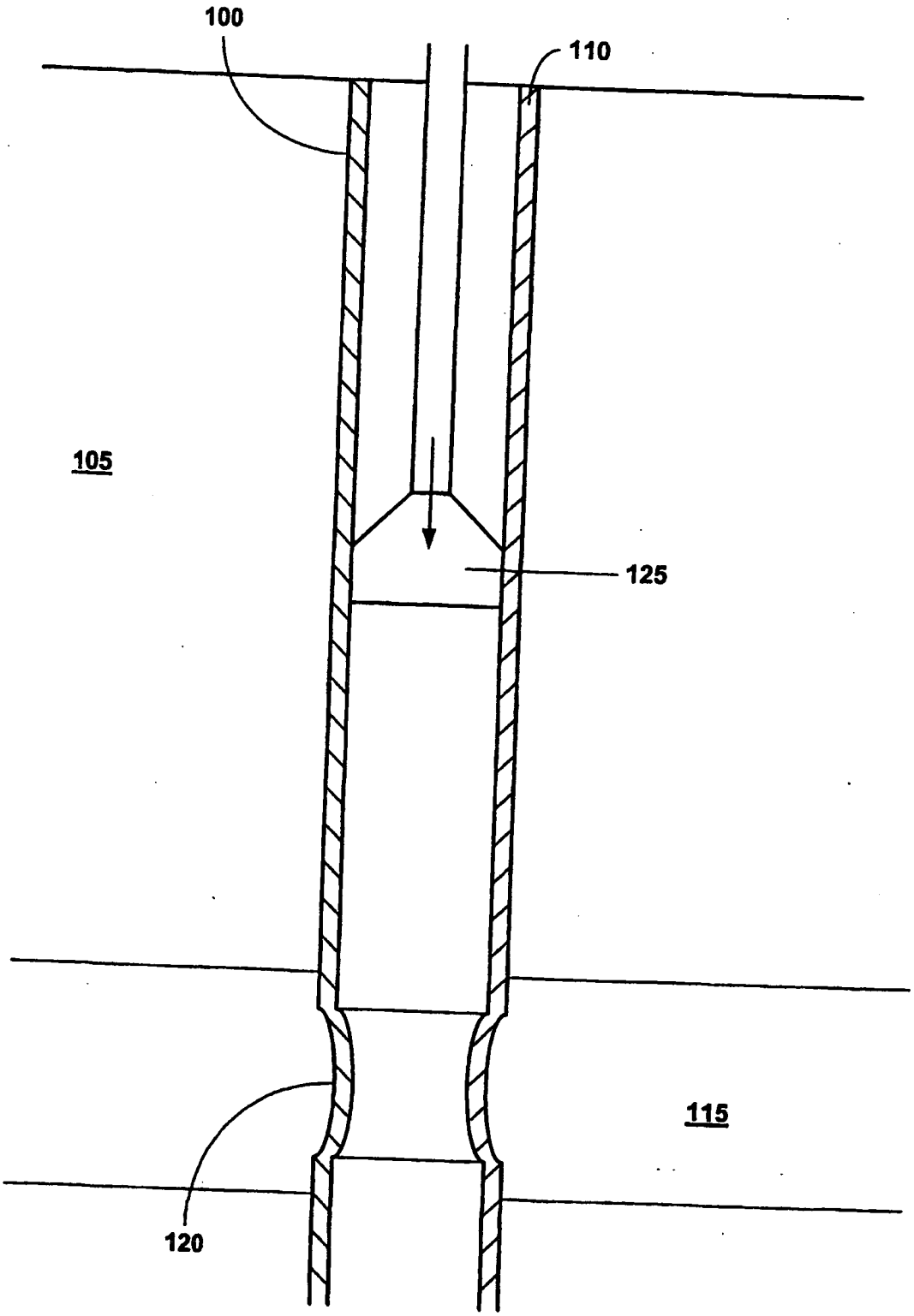


FIGURE 2

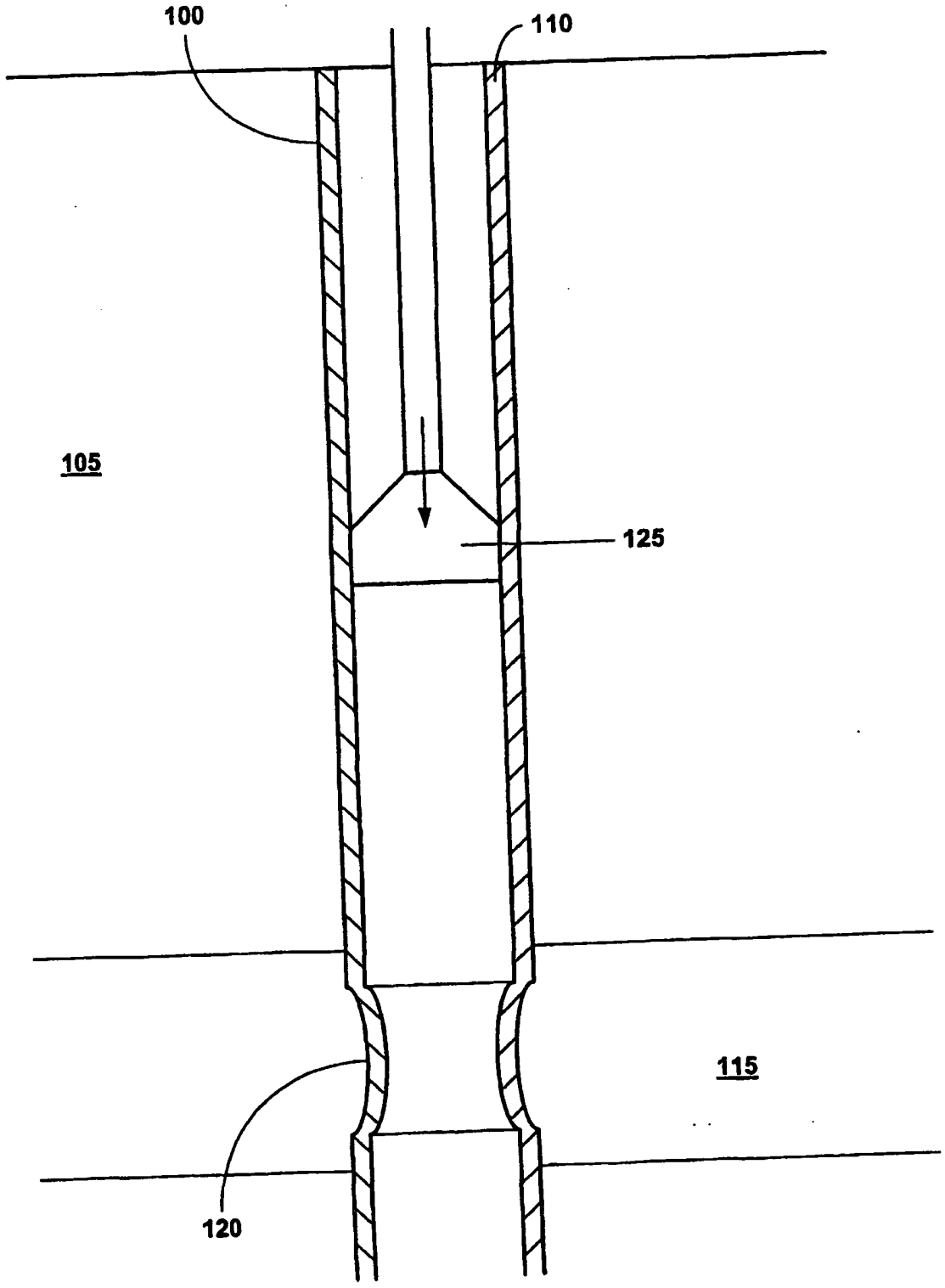


FIGURE 2

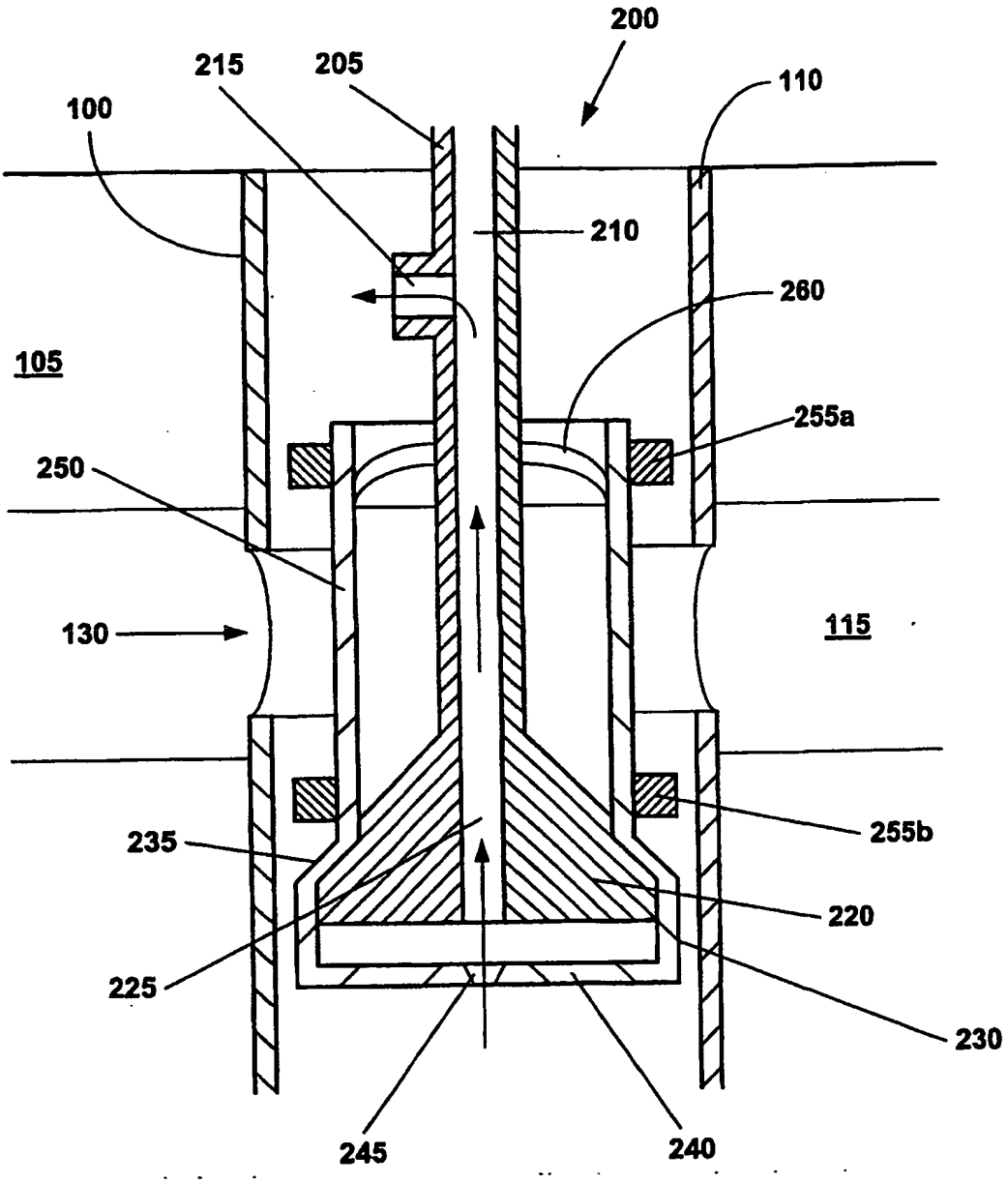

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FIGURE 4

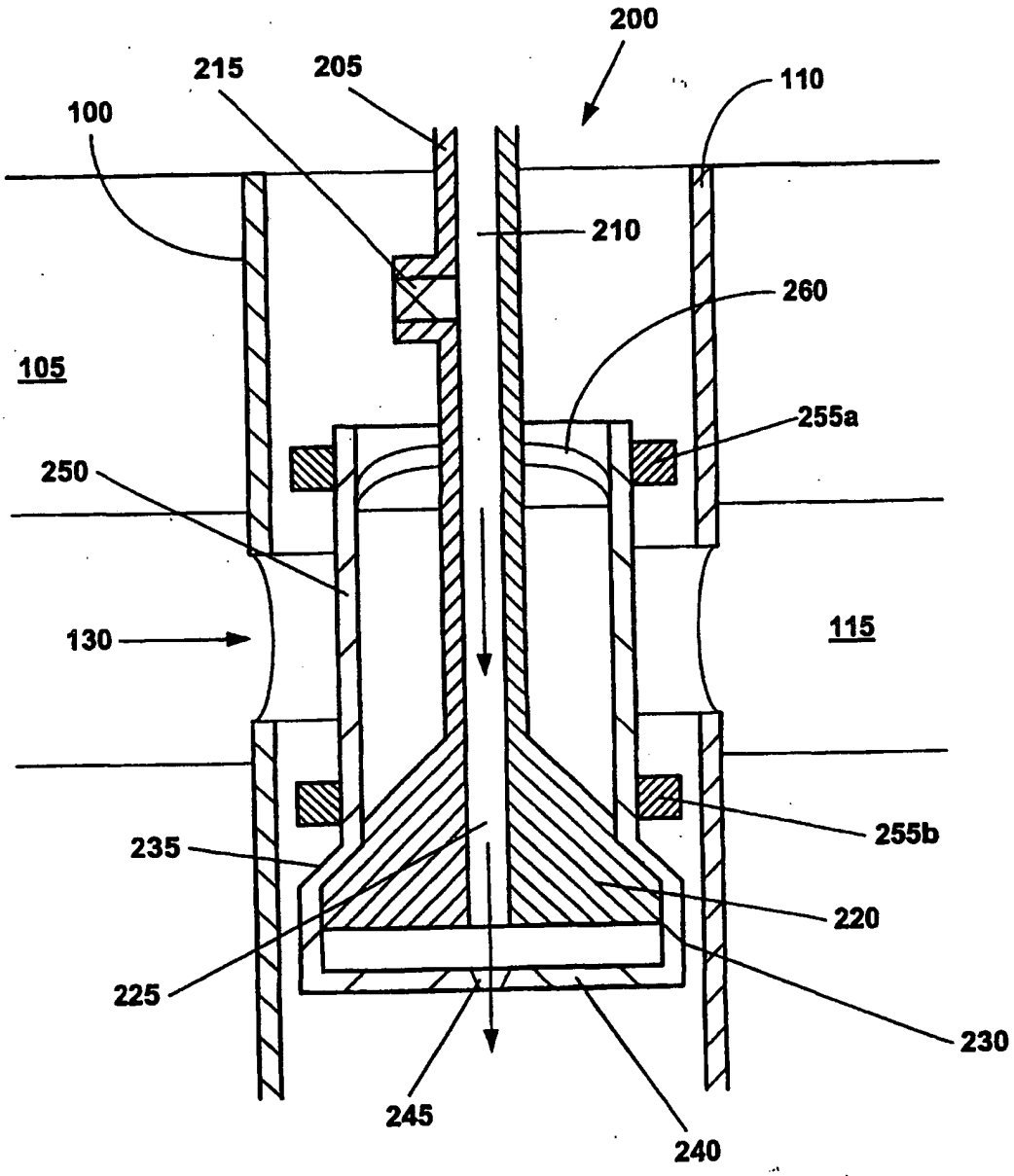

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FIGURE 5

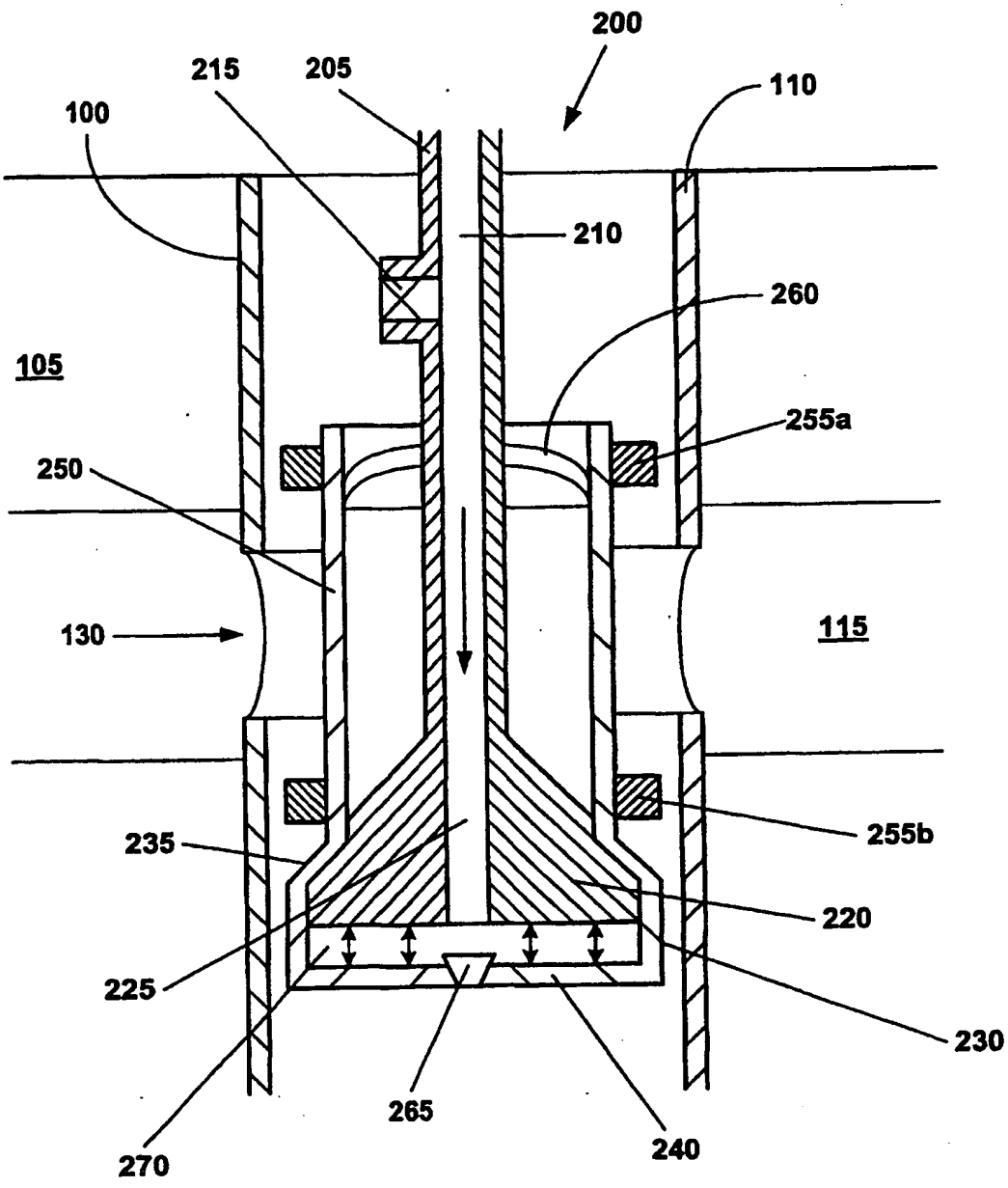

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FIGURE 6

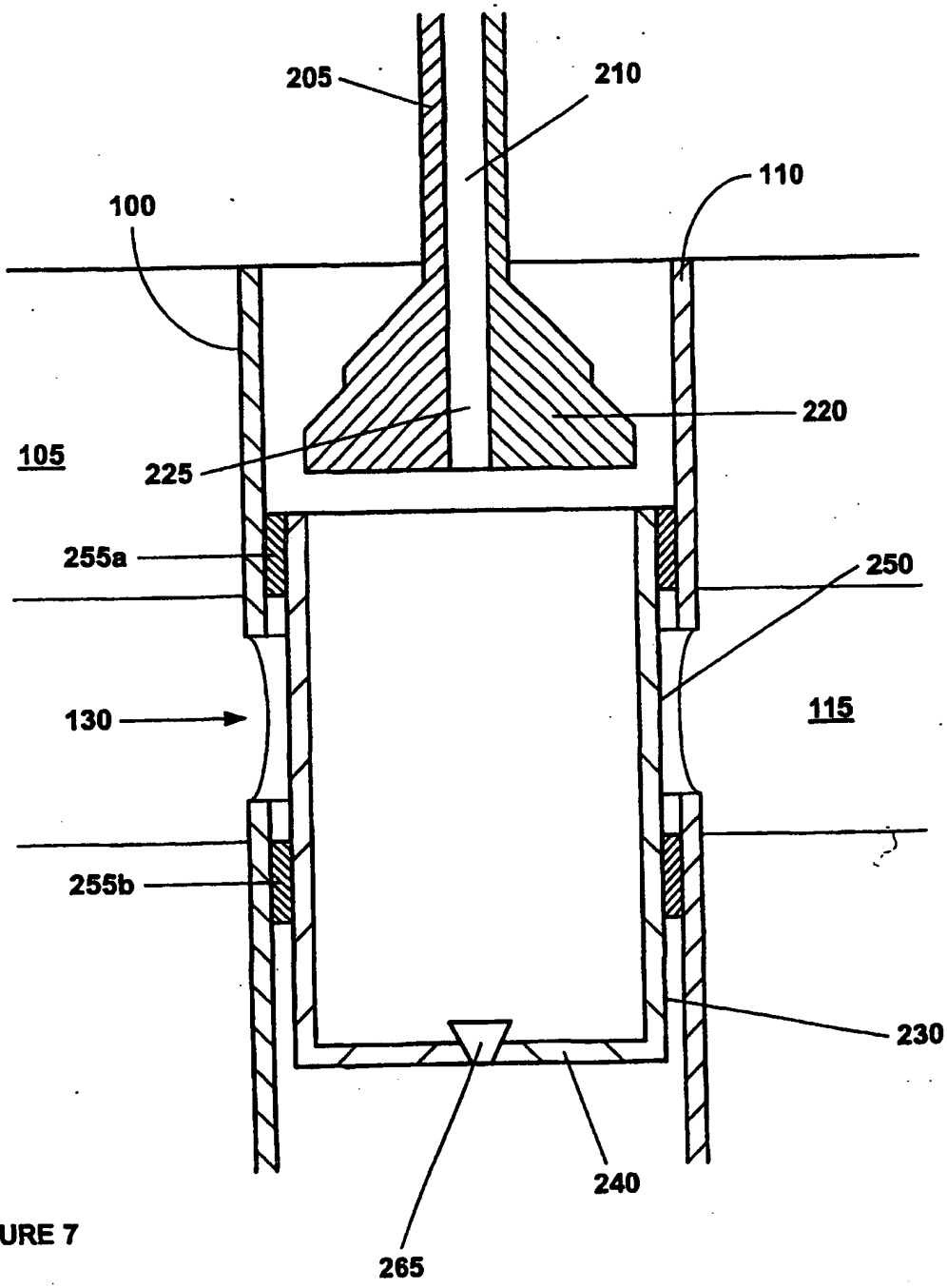


FIGURE 7

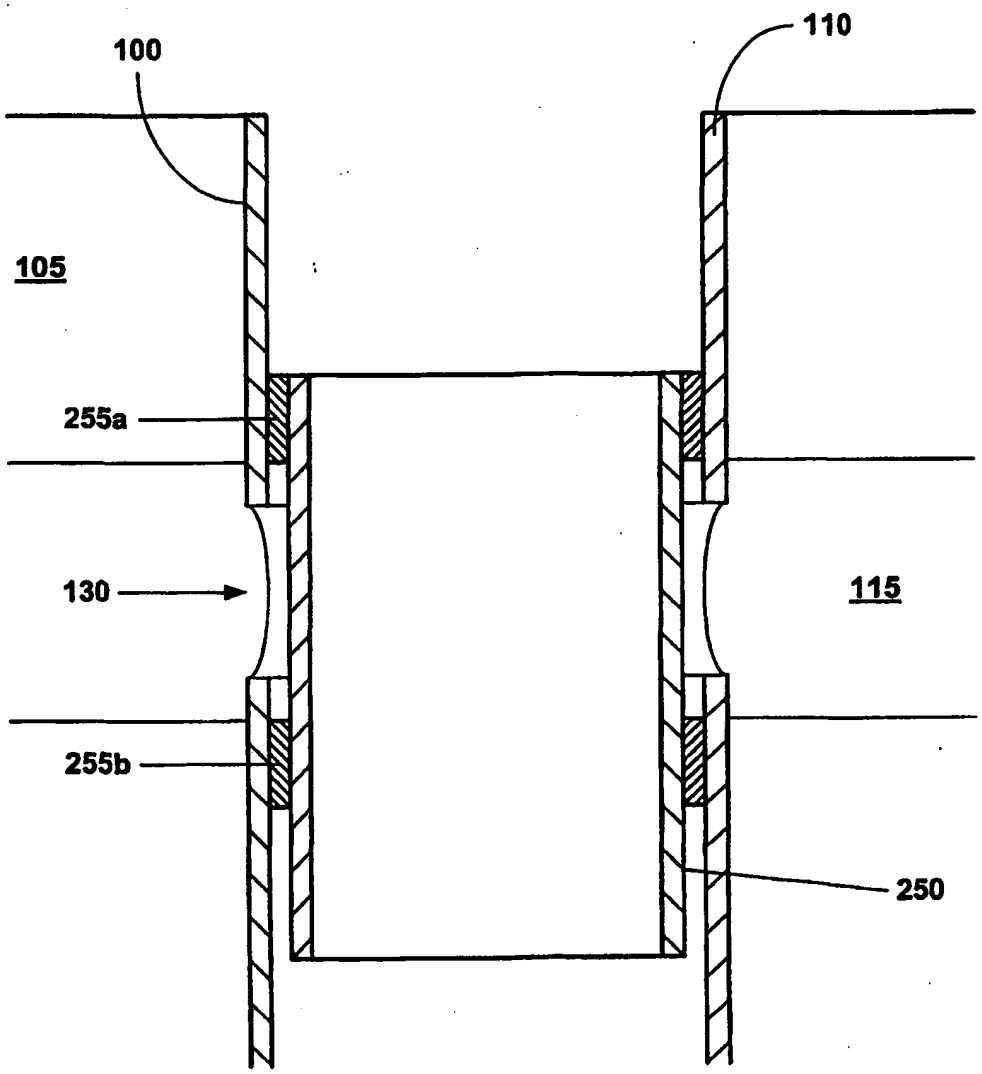


FIGURE 8

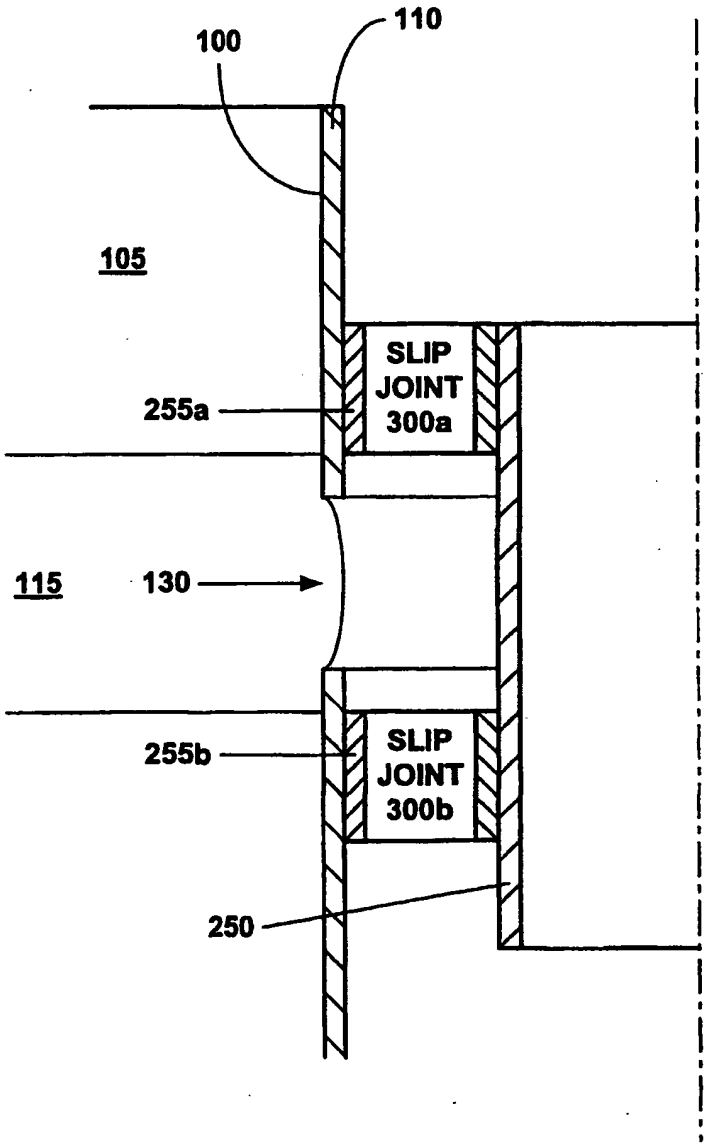

100
110
105
SLIP
JOINT
300a
255a
115
130
255b
SLIP
JOINT
300b
250

FIGURE 9

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LINER HANGER WITH SLIP JOINT SEALING MEMBERS

Background of the Invention

This invention relates generally to tubular members, and in particular to apparatus and methods for covering openings in tubular members.

Conventionally, when a wellbore casing is damaged, a tubular liner is positioned within the damaged section of the wellbore casing in order to provide structural support and prevent the undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. However, conventional tubular liners used for covering openings in tubular members suffer from a number of serious drawbacks. For example, conventional tubular liners used for covering openings in tubular members are not designed to accommodate variable loading conditions.

The present invention is directed to overcoming one or more of the limitations of the existing apparatus and methods for covering openings in tubular members.

Summary of the Invention

According to one aspect of the present invention, there is provided a method of covering an opening in a first tubular member, comprising:

covering at least a portion of the opening in the first tubular member with a floating tubular member; and

radially expanding at least a portion of the floating tubular member into contact with the first tubular member.

According to another aspect of the present invention, there is provided a system including a first tubular member for covering an opening in a second tubular member, comprising:

a first tubular member which is radially expandable; and

a slip joint coupled to the exterior surface of the first tubular member.

Preferred features of the invention are the subject of the dependent claims.

Brief Description of the Drawings

FIG. 1 is a cross-sectional view illustrating a wellbore casing including a damaged section.

FIG. 2 is a fragmentary cross-sectional view illustrating the introduction of a milling device into the wellbore casing of FIG. 1.

FIG. 3 is a fragmentary cross-sectional view illustrating the removal of at least a portion of the damaged section of the wellbore casing using the milling device to form an opening in the wellbore casing of FIG. 2.

FIG. 4 is a fragmentary cross-sectional view illustrating the placement of a repair apparatus for covering the opening in the wellbore casing of FIG. 3.

FIG. 5 is a fragmentary cross-sectional view illustrating the injection of fluidic materials into the repair apparatus of FIG. 4.

FIG. 6 is a fragmentary cross-sectional view illustrating the pressurization of the interior of the repair apparatus of FIG. 5.

FIG. 7 is a fragmentary cross-sectional view illustrating the completion of the radial expansion of the expandable tubular member of the repair apparatus of FIG. 6.

FIG. 8 is a cross-sectional view illustrating the milling out of the shoe of the radially expanded tubular member of FIG. 7.

FIG. 9 is a cross-sectional illustration of an embodiment of upper and lower sealing members that include internal slip joints.

Detailed Description of the Illustrative Embodiments

An apparatus and method for repairing an opening in a damaged section of a wellbore casing within a subterranean formation is provided. The apparatus and method provides a system for repairing an opening in a damaged section of a wellbore casing within a subterranean formation in which a tubular member is radially expanded into contact with the wellbore casing. The physical connection between the radially expanded tubular member and the wellbore casing is preferably compliant and permits movement of the radially expanded tubular member relative to the wellbore casing in at least the longitudinal direction. In this manner, the

radially expanded tubular member is capable of absorbing a wide range of loading conditions.

Referring initially to Fig. 1, a wellbore 100 positioned within a subterranean formation 105 includes a preexisting casing 110 that traverses a producing formation 115. The portion of the casing 110 that traverses the producing formation 115 includes a damaged section 120. As will be recognized by persons having ordinary skill in the art, the damaged section 120 may be caused by, for example, structural instabilities in the producing formation 115 such as, for example, subsidence that can cause buckling of the wellbore casing 110.

Referring to Figs. 2 and 3, in order to repair the damaged section 120 of the wellbore casing 110, a conventional milling device 125 is then inserted into the wellbore casing 110. The milling device 125 is then used to remove at least a portion of the damaged section 120 of the wellbore casing 110 and thereby form an opening 130 in the wellbore casing 110.

Referring to Fig. 4, an apparatus 200 for repairing the opening 130 in the wellbore casing 110 may then be positioned within the wellbore casing proximate the opening in the wellbore casing.

The apparatus 200 includes a tubular support member 205 having a longitudinal passage 210 and a transverse passage 215 that is coupled to an expansion cone 220 having a longitudinal passage 225 that is fluidicly coupled to the longitudinal passage 210. The expansion cone 220 is at least partially received within an expansion cone launcher 230 that includes a thin-walled annular member 235 and a shoe 240 having an exhaust passage 245. An expandable tubular member 250 extends from the expansion cone launcher 230 that includes upper and lower sealing members 255a and 255b affixed to the exterior surface of the expandable tubular member. A sealing cup 260 is attached to the exterior surface of the tubular support member 205 for preventing foreign materials from entering the interior of the expandable tubular member 250.

As illustrated in Fig. 4, during placement of the apparatus 200 within the wellbore casing 110, fluidic materials displaced by the apparatus 200 are conveyed

through the longitudinal passages 210 and 225 to the transverse passage 215. In this manner, surge pressures during the placement of the apparatus 200 within the wellbore casing 110 are minimized. Furthermore, as illustrated in Fig. 4, the apparatus 200 is preferably positioned with the tubular member 250 in opposing relation to the opening 130 in the wellbore casing 110. In this manner, the upper and lower sealing members 255a and 255b may engage portions of the wellbore casing 110 above and below the opening 130 after radially expanding the tubular member 250.

As illustrated in Fig. 5, the transverse passage 215 may then be closed and fluidic materials injected into the apparatus 200 through the longitudinal passage 210. In this manner, any blockages within any of the passages 210, 225, and 245 may be detected by monitoring the operating pressure whereby an increase in operating pressure above nominal, or predetermined, conditions may indicate a blockage of one of the passages.

As illustrated in Fig. 6, a plug 265 or other conventional stop member may then be introduced into the fluidic materials injected into the apparatus 200 through the passage 210, and the plug 265 may be positioned within the passage 245. In this manner, the passage 245 may be sealed off. Thus, continued injection of fluidic materials into the apparatus 200 through the passage 210 may thereby pressurize a region 270 below the expansion cone 220.

As illustrated in Fig. 7, continued pressurization of the region 270 causes the expansion cone 220 to radially expand the expandable tubular member 250 off of the expansion cone. In this manner, the upper and lower sealing members 255a and 255b preferably engage the interior walls of the wellbore casing 110 above and below the opening 130 thereby sealing off the opening. In a preferred embodiment, during the radial expansion process, the tubular support member 205 is raised out of the wellbore 100.

As illustrated in Fig. 8, the shoe 240 may then be removed using a conventional milling device. In this manner, exploration and production of

subterranean regions beyond the opening 130 in the wellbore casing 110 may be conducted.

In several alternative embodiments, the upper sealing member 255a or the lower sealing member 255b are omitted from the tubular member 250. In this manner, the radially expanded tubular member 250 is permitted to float relative to the wellbore casing 110. Furthermore, in this manner, relative longitudinal and/or transverse movements of the sections of the wellbore casing 110 above and below the opening 130 may be optimally accommodated by the radially expanded tubular member 250. Finally, in this manner, damage to the radially expanded tubular member 250 that can be caused by longitudinal stresses, such as buckling, may be minimized or eliminated.

In another alternative embodiment, as illustrated in Fig. 9, the upper sealing member 255a and/or the lower sealing member 255b include internal slip joints 300a and 300b in order to permit the radially expanded tubular member 250 to float relative to the wellbore casing 110. In this manner, relative longitudinal and/or transverse movements of the sections of the wellbore casing 110 above and below the opening 130 may be optimally accommodated. Furthermore, in this manner, damage to the radially expanded tubular member 250 that can be caused by longitudinal stresses, such as buckling, may be minimized or eliminated.

In a preferred embodiment, the sealing members 255a and 255b permit the radially expanded tubular member 250 to move in the longitudinal direction while also maintaining a fluidic seal. In several alternative embodiments, the sealing members 255a and 255b are fabricated from a resilient material such as, for example, synthetic or natural rubber.

It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, the apparatus 200 may be used to repair, for example, a wellbore casing, a pipeline, or a structural support.

Although illustrative embodiments of the invention have been shown and described, a wide range of modifications, changes and substitutions are contemplated in the foregoing disclosure within the scope of the claims.

CLAIMS

1. A method of covering an opening in a first tubular member, comprising:

covering at least a portion of the opening in the first tubular member with a floating tubular member; and

radially expanding at least a portion of the floating tubular member into contact with the first tubular member.

2. The method of claim 1, further comprising:

coupling the floating tubular member to the first tubular member with a slip joint.

3. The method of claim 1, wherein the radially expanded floating tubular member contacts the first tubular member above and below the opening.

4. The method of claim 1, wherein the radially expanded floating tubular member only contacts the first tubular member above the opening.

5. The method of claim 1, wherein the radially expanded floating tubular member only contacts the first tubular member below the opening.

6. A system including a first tubular member for covering an opening in a second tubular member, comprising:

a first tubular member which is radially expandable; and

a slip joint coupled to the exterior surface of the first tubular member.

7. The system of claim 6, further comprising:

a tubular support member comprising a first passage;

an expansion device coupled to the tubular support member comprising a second passage fluidicly coupled to the first passage; and

an expansion device launcher coupled to the expansion device comprising a shoe having an exhaust passage; wherein

the first tubular member is coupled to the expansion device launcher , and comprises one or more sealing members having slip joints.

8. The system of claim 6 further comprising:

means for removing at least a portion of a damaged section of the second tubular member to create the opening in the second tubular member; and

means for covering at least a portion of the opening in the second tubular member with the first tubular member.

9. The system of claim 8, further comprising:

means for coupling the first tubular member to the second tubular member with the slip joint.

10. The system of claim 8, wherein the means for covering at least a portion of the opening in the second tubular member with the first tubular member comprises:

means for radially expanding at least a portion of the first tubular member into contact with the second tubular member.

11. The system of claim 10, wherein the means for radially expanding the first tubular member comprises:

means for radially expanding the first tubular member into contact with the second tubular member above and below the opening.

12. The system of claim 10, wherein the radially expanded first tubular member only contacts the second tubular member above the opening.

13. The system of claim 10, wherein the radially expanded first tubular member only contacts the second tubular member below the opening.

14. The method of claim 1, wherein the first tubular member comprises a damaged section of a pipeline, the method further comprising:

removing at least a portion of the damaged section of the pipeline to create the opening in the pipeline; and

covering at least a portion of the opening in the pipeline with the floating tubular member.

15. The method of claim 14, further comprising:

coupling the floating tubular member to the pipeline with a slip joint.

16. The method of claim 14, wherein covering at least a portion of the opening in the pipeline with the floating tubular member comprises:

radially expanding at least a portion of the floating tubular member into contact with the pipeline.

17. The method of claim 16, wherein the radially expanded floating tubular member contacts the pipeline above and below the opening.

18. The method of claim 16, wherein the radially expanded floating tubular member only contacts the pipeline above the opening.

19. The method of claim 16, wherein the radially expanded floating tubular member only contacts the pipeline below the opening.

20. The system of claim 6, wherein the second tubular member comprises a pipeline.

21. The system of claim 20, further comprising:

a tubular support member comprising a first passage;

an expansion device coupled to the tubular support member comprising a second passage fluidicly coupled to the first passage; and

an expansion device launcher coupled to the expansion device comprising a shoc having an exhaust passage; wherein

the first tubular member is coupled to the expansion device launcher and comprises one or more sealing members having slip joints.

22. The system of claim 20, wherein the first tubular member is coupled to the pipeline in opposing relation to the opening.

23. The system of claim 20, wherein the pipeline comprises a damaged section, further comprising:

means for removing at least a portion of the damaged section of the pipeline to create the opening in the pipeline; and

means for covering at least a portion of the opening in the pipeline with the first tubular member.

24. The system of claim 23, further comprising:

means for coupling the first tubular member to the pipeline with the slip joint.

25. The system of claim 23, wherein the means for covering at least a portion of the opening in the pipeline with the first tubular member comprises:

means for radially expanding at least a portion of the first tubular member into contact with the pipeline.

26. The system of claim 25, wherein the means for radially expanding the first tubular member comprises:

means for radially expanding the first tubular member into contact with the pipeline above and below the opening.

27. The system of claim 25, wherein the radially expanded first tubular member only contacts the pipeline above the opening.

28. The system of claim 25, wherein the radially expanded first tubular member only contacts the pipeline below the opening.

29. The method of claim 1, wherein the first tubular member comprises a structural support comprising a damaged section, the method further comprising:

removing at least a portion of the damaged section of the structural support to create the opening in the structural support; and

covering at least a portion of the opening in the structural support with the floating tubular member.

30. The method of claim 29, further comprising:

coupling the floating tubular member to the structural support with a slip joint.

31. The method of claim 29, wherein covering at least a portion of the opening in the structural support with the floating tubular member comprises:

radially expanding at least a portion of the floating tubular member into contact with the structural support.

32. The method of claim 31, wherein the radially expanded floating tubular member contacts the structural support above and below the opening.

33. The method of claim 31, wherein the radially expanded floating tubular member only contacts the structural support above the opening.

34. The method of claim 31, wherein the radially expanded floating tubular member only contacts the structural support below the opening.

35. The system of claim 6, wherein the second tubular member comprises a structural support.

36. The system of claim 35, further comprising:

a tubular support member comprising a first passage;

an expansion device coupled to the tubular support member comprising a second passage fluidicly coupled to the first passage; and

an expansion device launcher coupled to the expansion device comprising a shoe having an exhaust passage; wherein

the first tubular member is coupled to the expansion device launcher and comprises one or more sealing members having slip joints.

37. The system of claim 35 wherein the first tubular member is coupled to the structural support in opposing relation to the opening.

38. The system of claim 35 further comprising:

means for removing at least a portion of a damaged section of the structural support to create the opening in the structural support; and

means for covering at least a portion of the opening in the structural support with the first tubular member.

39. The system of claim 38, further comprising:

means for coupling the first tubular member to the structural support with the slip joint.

40. The system of claim 38, wherein the means for covering at least a portion of the opening in the structural support with the first tubular member comprises:

means for radially expanding at least a portion of the first tubular member into contact with the structural support.

41. The system of claim 40, wherein the means for radially expanding the first tubular member comprises:

means for radially expanding the first tubular member into contact with the structural support above and below the opening.

42. The system of claim 40, wherein the radially expanded first tubular member only contacts the structural support above the opening.

43. The system of claim 40, wherein the radially expanded first tubular member only contacts the structural support below the opening.

44. The system of claim 7, wherein the expansion device comprises an expansion cone.

45. The system of claim 21, wherein the expansion device comprises an expansion cone.

46. The system of claim 36, wherein the expansion device comprises an expansion cone.

47. The system of claim 6, wherein the slip joint permits relative longitudinal and/or transverse movements of the first tubular member relative to the second tubular member.

48. The method of claim 1, wherein the floating tubular member may be displaced in the longitudinal and/or transverse directions relative to the first tubular member.

49. A method of covering an opening in a first tubular member substantially as described herein with reference to and as illustrated in Figures 1-9 of the accompanying drawings.

50. A system for covering an opening in a tubular member substantially as described herein with reference to and as illustrated in Figures 1-9 of the accompanying drawings.

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